## What is claimed is:

- 1. A process for forming a metal damascene structure,
  comprising the following steps:
- forming a dielectric layer on a substrate;
- 4 etching the dielectric layer to form a damascene
- 5 opening;
- 6 providing a plasma treatment to remove remaining
- 7 impurities on the dielectric layer; and
- filling a metal in the damascene opening.
- 1 2. The process as claimed in claim 1, wherein the
- 2 plasma treatment uses a hydrogen-containing plasma, a
- nitrogen-containing plasma, an oxygen-containing plasma,
- 4 or mixtures thereof.
- 1 3. The process as claimed in claim 2, wherein the
- 2 hydrogen-containing plasma is hydrogen (H<sub>2</sub>) plasma or
- 3 ammonia (NH<sub>3</sub>) plasma.
- 1 4. The process as claimed in claim 2, wherein the
- 2 nitrogen-containing plasma is nitrogen (N2) plasma or
- 3 ammonia (NH<sub>3</sub>) plasma.
- 1 5. The process as claimed in claim 2, wherein the
- 2 oxygen-containing plasma is  $N_2O$  plasma or oxygen  $(O_2)$
- 3 plasma.
- 1 6. The process as claimed in claim 2, where the plasma
- 2 treatment step uses H<sub>2</sub> plasma, NH<sub>3</sub> plasma, H<sub>2</sub>/NH<sub>3</sub> plasma,
- 3 or  $H_2/N_2$  plasma.

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- 7. The process as claimed in claim 1, wherein the damascene opening is a via.
- 8. The process as claimed in claim 7, wherein the damascene opening further comprises a trench above the via.
- 9. The process as claimed in claim 8, wherein the metal filling step includes filling copper or copper alloy in the trench and the via.
- 1 10. The process as claimed in claim 1, before the 2 dielectric layer is formed, further comprising forming a 3 first metal layer on the substrate.
- 1 11. The process as claimed in claim 10, wherein the 2 first metal layer is copper or copper alloy.
- 1 12. The process as claimed in claim 11, wherein the 2 plasma treatment is performed on the surface of the first 3 metal layer.
- 1 13. The process as claimed in claim 12, wherein the 2 plasma treatment removes remaining impurities on the 3 first metal layer.
- 1 14. The process as claimed in claim 12, wherein the 2 plasma treatment repairs the bonding between the first 3 metal layer and the dielectric layer.
- 1 15. The process as claimed in claim 10, after the 2 first metal layer is formed and before the dielectric

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- 3 layer is formed, further comprising forming a cap layer
- 4 on the first metal layer.
- 1 16. The process as claimed in claim 15, wherein the
- 2 cap layer is nitride or silicon carbide.
- 1 17. The process as claimed in claim 15, wherein the
- 2 plasma treatment repairs the bonding between the first
- 3 metal layer and the cap layer.
- 1 18. A process for forming a metal damascene
- 2 structure, comprising the following steps:
- forming a cap layer on a first metal layer;
- forming a dielectric layer on the cap layer;
- 5 etching the dielectric layer with
- 6 fluorine-containing plasma or
- 7 chlorine-containing plasma to form a damascene
- 8 opening;
- 9 plasma treating using a hydrogen-containing plasma;
- 10 and
- filling a metal in the damascene opening.
  - 1 19. The process as claimed in claim 18, wherein the
  - 2 hydrogen-containing plasma is hydrogen (H<sub>2</sub>) plasma or
  - 3 ammonia (NH<sub>3</sub>) plasma.
  - 1 20. The process as claimed in claim 18, wherein the
  - 2 plasma treatment step uses  $H_2$  plasma,  $NH_3$  plasma,  $H_2/NH_3$
  - 3 plasma, or  $H_2/N_2$  plasma.
  - 1 21. The process as claimed in claim 18, wherein the
  - 2 damascene opening is a via.

- 1 22. The process as claimed in claim 21, wherein the
- 2 damascene opening further comprises a trench above the
- 3 via.
- 1 23. The process as claimed in claim 22, wherein the
- 2 metal filling step includes filling copper or copper alloy
- 3 in the trench and the via.
- 1 24. The process as claimed in claim 18, wherein the
- 2 first metal layer is copper or copper alloy.
- 1 25. The process as claimed in claim 18, wherein the
- 2 cap layer is nitride or silicon carbide.
- 1 26. A process for forming a metal damascene
- 2 structure, comprising the following steps:
- forming a cap layer on a first metal layer, wherein
- the cap layer is a nitride layer;
- forming a dielectric layer on the cap layer;
- etching the dielectric layer to form a damascene
- 7 opening;
- plasma treating using a nitrogen-containing plasma;
- 9 and
- filling a metal in the damascene opening.
  - 1 27. The process as claimed in claim 26, wherein the
  - 2 etching step uses fluorine-containing plasma or
  - 3 chlorine-containing plasma.
  - 1 28. The process as claimed in claim 26, wherein the
  - 2 nitrogen-containing plasma is nitrogen (N₂) plasma.

29. The process as claimed in claim 26, wherein the 1 plasma treatment step uses NH<sub>3</sub> plasma, N<sub>2</sub> plasma, H<sub>2</sub>/NH<sub>3</sub> 2 plasma, or  $H_2/N_2$  plasma. 3 30. The process as claimed in claim 26, wherein the 1 damascene opening is a via. 2 31. The process as claimed in claim 30, wherein the 1 damascene opening further comprises a trench above the 2 3 via. 32. The process as claimed in claim 31, wherein the 1 metal filling step includes filling copper or copper alloy 2 in the trench and the via. 3 33. The process as claimed in claim 26, wherein the 1 first metal layer is copper or copper alloy. 2 A process for forming a metal damascene 1 structure, comprising the following steps: 2 forming a cap layer on a first metal layer; 3 forming a dielectric layer on the cap layer; 4 forming a photoresist pattern on the dielectric 5 photoresist the pattern wherein 6 layer, contains carbon; 7 etching the dielectric layer using the photoresist 8 pattern as a mask to form a damascene opening; 9 plasma treating using an oxygen-containing plasma; 10 and 11

filling a metal in the damascene opening.

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- 1 35. The process as claimed in claim 34, wherein the 2 etching step uses fluorine-containing plasma or
- 3 chlorine-containing plasma.
- 1 36. The process as claimed in claim 34, wherein the
- 2 oxygen-containing plasma is  $N_2O$  plasma or oxygen  $(O_2)$
- 3 plasma.
- 1 37. The process as claimed in claim 34, wherein the
- 2 damascene opening is a via.
- 1 38. The process as claimed in claim 37, wherein the
- 2 damascene opening further comprises a trench above the
- 3 via.
- 1 39. The process as claimed in claim 38, wherein the
- 2 metal filling step includes filling copper or copper alloy
- 3 in the trench and the via.
- 1 40. The process as claimed in claim 34, wherein the
- 2 cap layer is nitride or silicon carbide.